

# ANGULAR MOMENTUM OF FISSION FRAGMENTS IN THE NEAR BARRIER REACTION OF $^{32}\text{S} + ^{197}\text{Au}$



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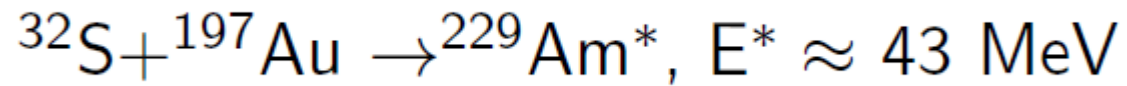
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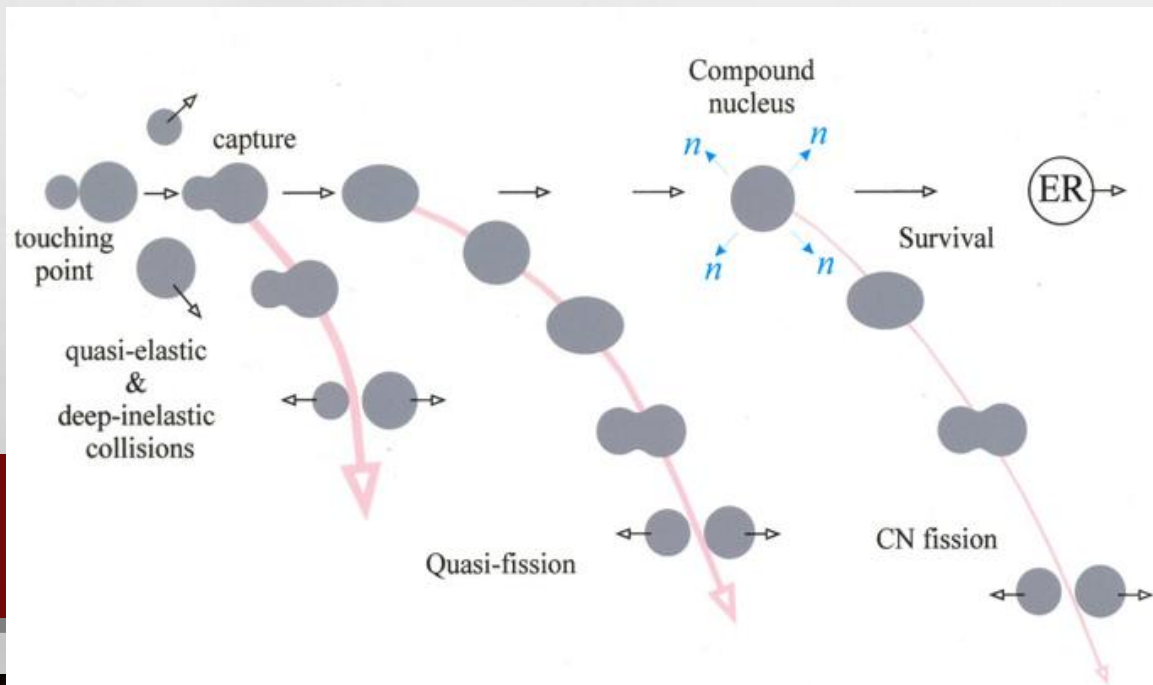
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# MOTIVATION AND GOAL : CHALLENGING FISSION AROUND THE INTERACTION BARRIER

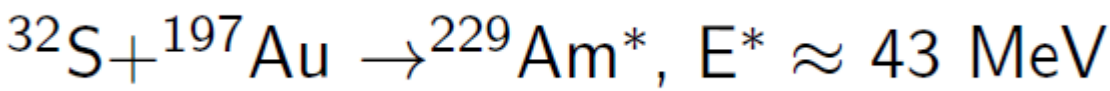


- ▶ **Coupling of 3 detection systems: CORSET + ORGAM + PARIS;**
- ▶ **Extracting details on the shell effects characterizing two competing processes **fusion-fission (CNF)** and **quasi-fission (QF)** : (A, TKE) correlation;**
- ▶ **Measurement of prompt  $\gamma$ -rays in coincidence with binary reaction fragments obtained in the reactions : *low and high energy*  $\gamma$ -rays for further insight.**



- Are population and feedings of specific isotopes preferred in different mechanisms or CNF modes?
- How does the  $\gamma$ -ray multiplicity or the sum energy evolve with fragment mass A, TKE or their variances?

# EXPERIMENTAL SETUP: CORSET



• **CORSET:**

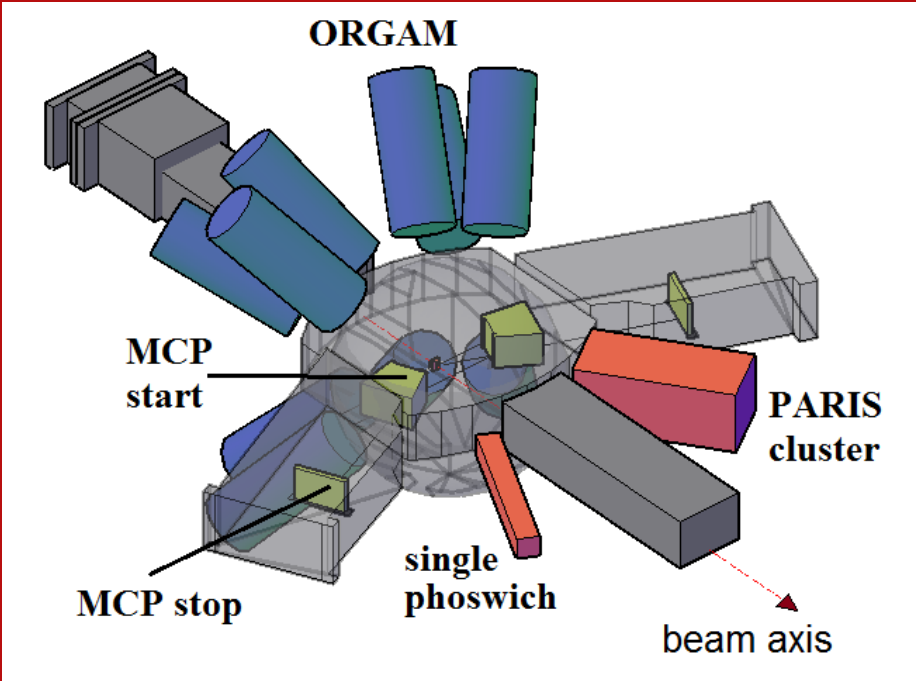
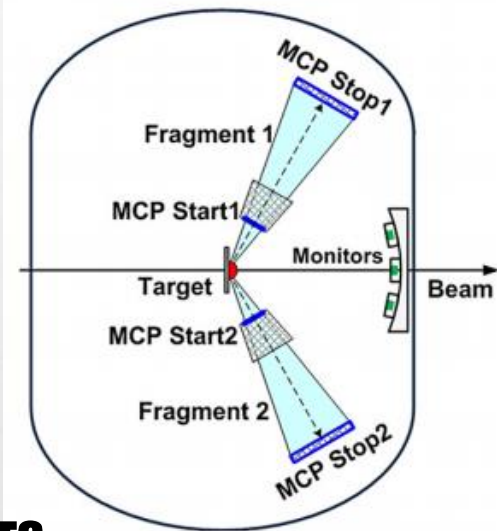
**MEASURED PARAMETERS:**

• **TOF, X, Y**

**EXTRACTED PARAMETERS:**

• **VELOCITY, ENERGY, ANGLES**

• **MASS OF FISSION FRAGMENTS**



| Parameter                                  | Value                 |
|--------------------------------------------|-----------------------|
| The Coulomb barrier (in lab. sys)          | 166 MeV               |
| Irradiation time                           | ~4 days               |
| Beam current                               | ~ 90 nA               |
| Collected statistics for fission fragments | ~ 2 · 10 <sup>6</sup> |
| Excitation energy of the CN                | ~43 MeV               |

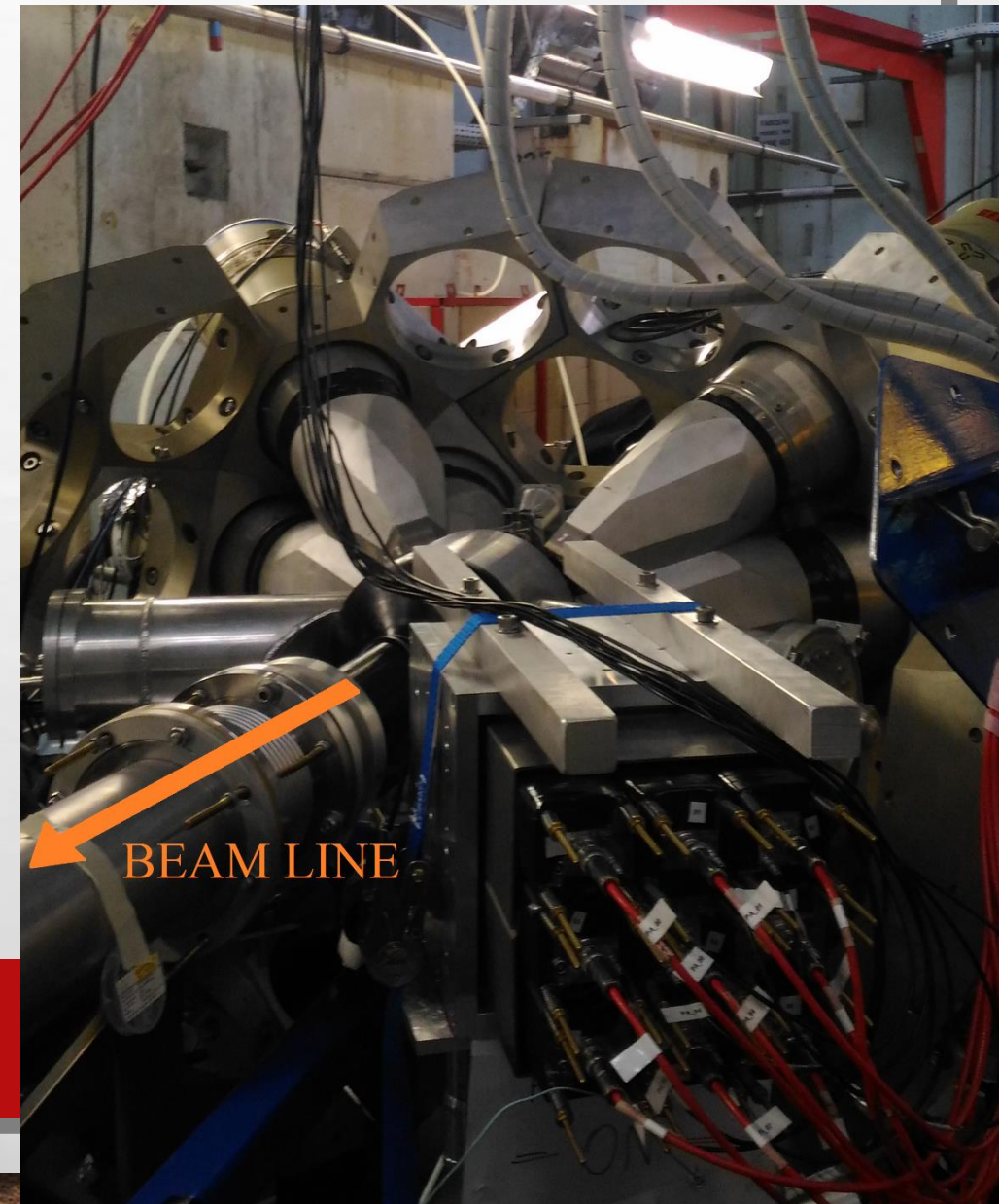


# Experimental Setup: Coincident $\gamma$ -rays

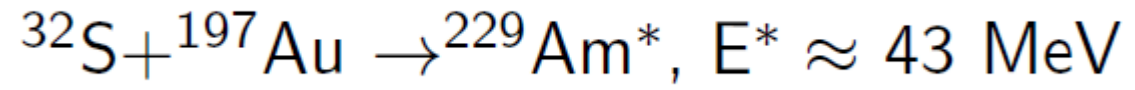
- ORGAM & PARIS : PROMPT  $\gamma$ -RAYS COINCIDENT**

**WITH FISSION FRAGMENTS (FF).**

| Parameter                    | ORGAM                      | PARIS                                          |
|------------------------------|----------------------------|------------------------------------------------|
| Number and type of Detectors | 10 x Ge + BGO shielding    | 10 x LaBr <sub>3</sub> (Ce)-NaI(Tl) (phoswich) |
| Photo-peak Efficiency        | ~1%                        | ~1%                                            |
| Energy resolution            | 2.6(3.4)keV @121(1408)keV  | 62keV @1332keV                                 |
| Dynamical range              | $E_\gamma < 2.5\text{MeV}$ | $E_\gamma < 15\text{MeV}$                      |



# CORSET Data

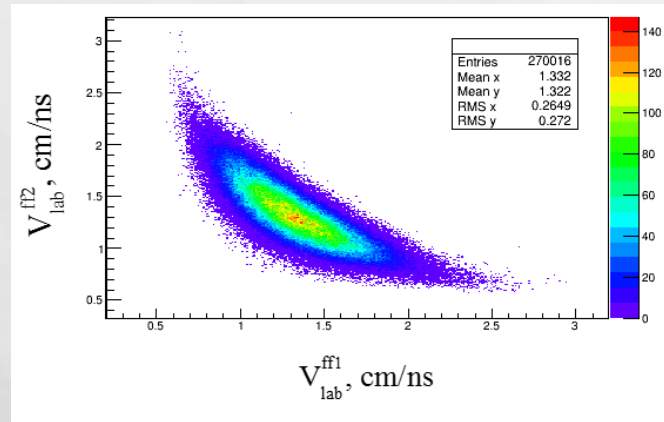


| $E_{\text{lab}}$ (MeV) | $\theta_{\text{lab}}^{\text{grazing}}$ (deg) | $\eta_0$ | $Z_p Z_t$ | $B_{\text{lab}}^{\text{Bass}}$ (MeV) |
|------------------------|----------------------------------------------|----------|-----------|--------------------------------------|
| 166                    | 141.5                                        | 0.72     | 1264      | 164.8                                |

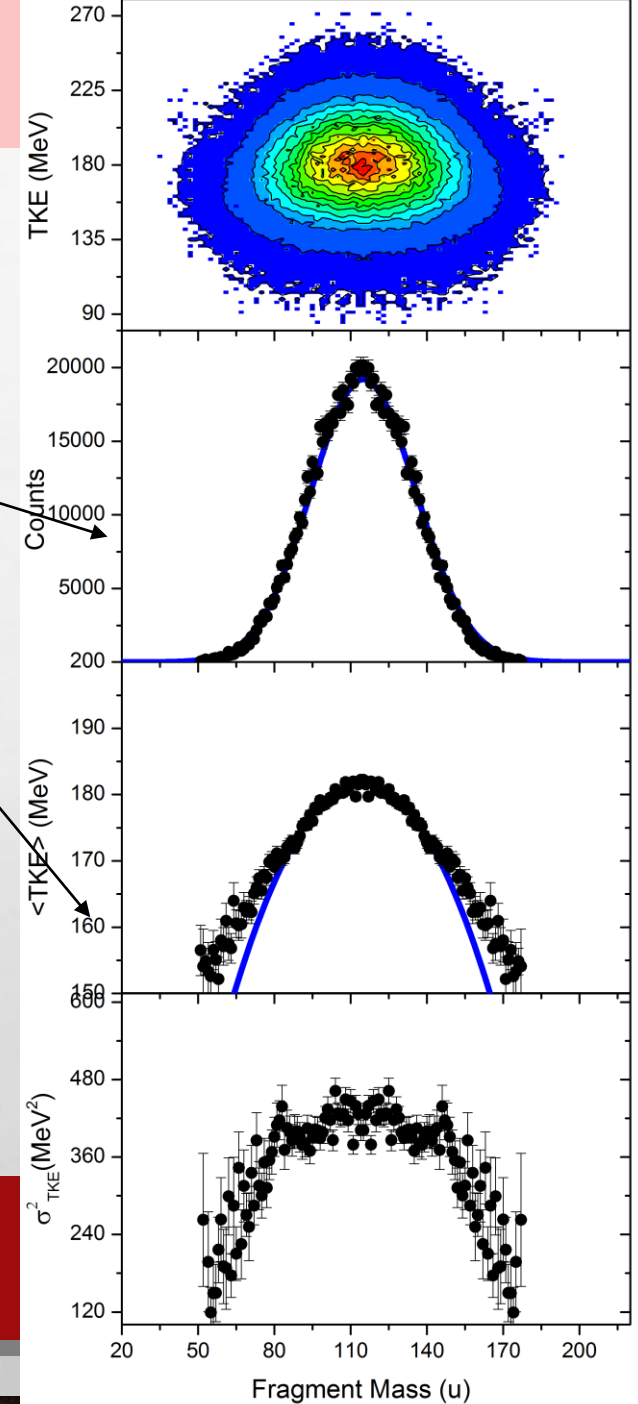


**Access to velocity vectors of FF and angles between FF and  $\gamma$ -ray detectors granted**

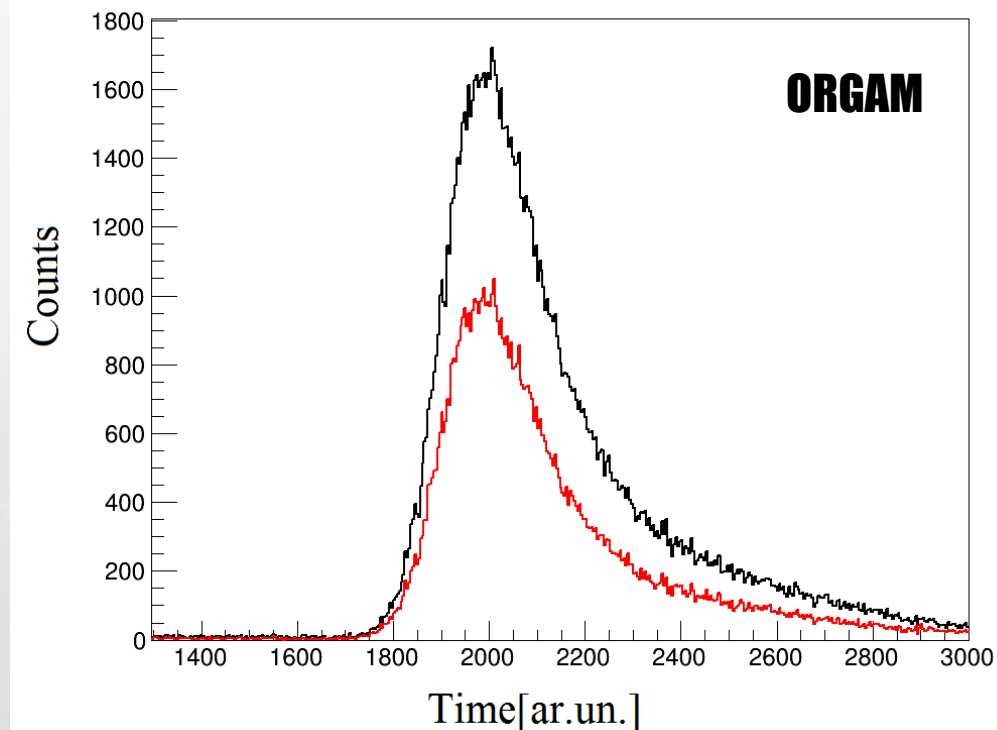
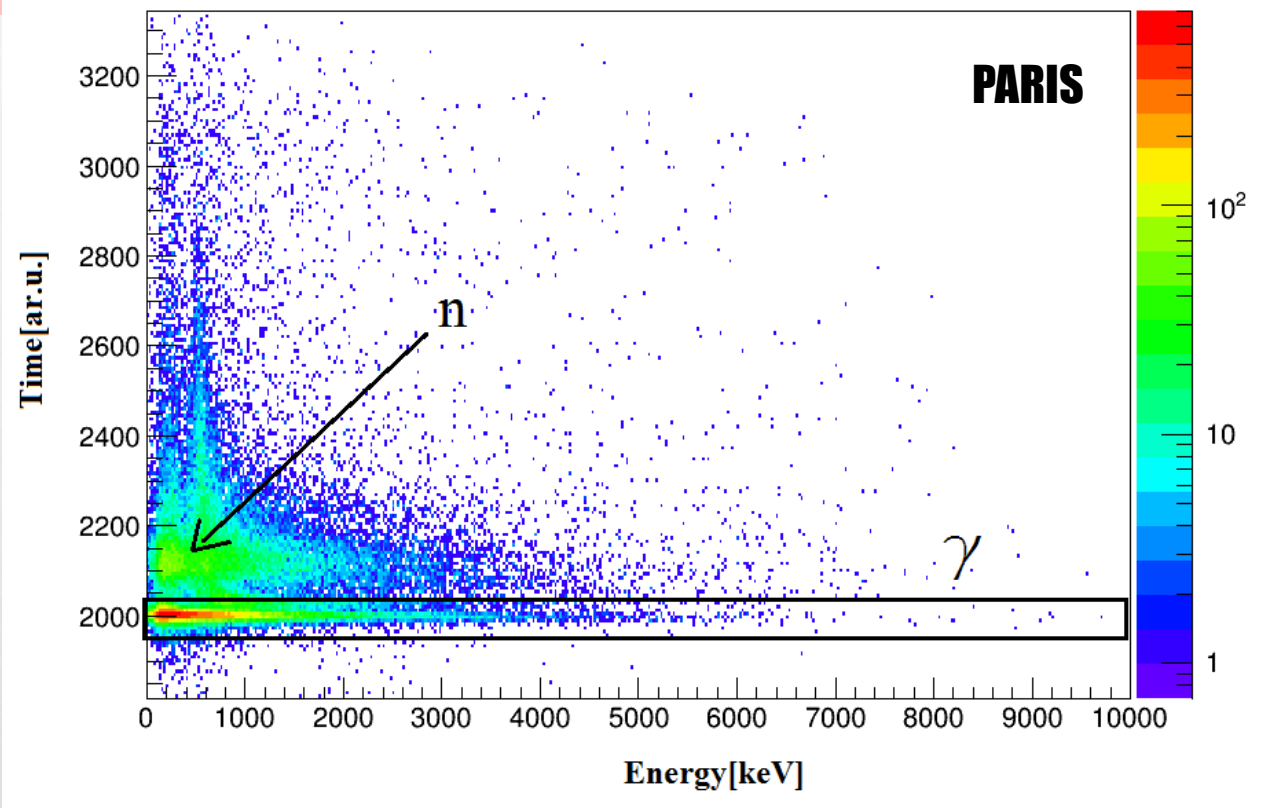
**to be used for precise Doppler corrections on  $\gamma$ -ray energies**



**LDM prediction**



# $\gamma$ -Coincident with FF

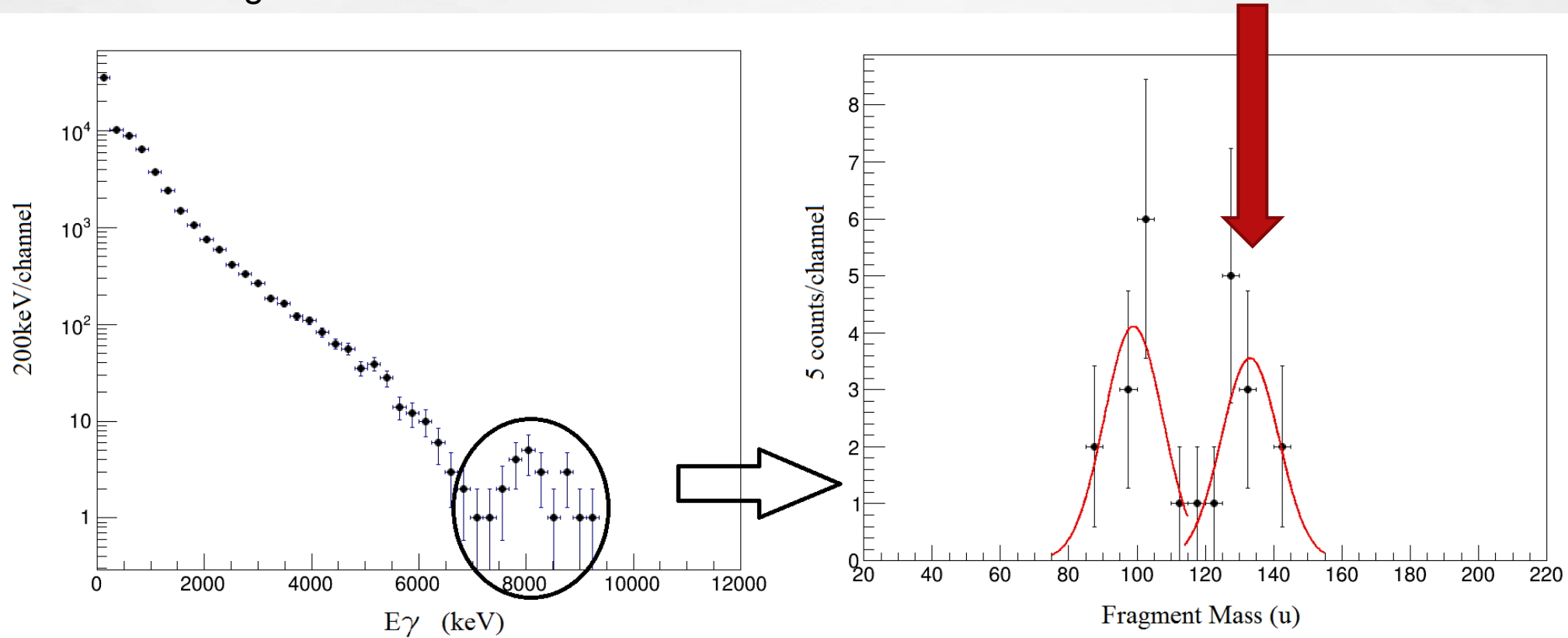


- **GOOD TIME RESOLUTION ALLOWING DISCRIMINATION OF  $\gamma$ -RAYS AGAINST NEUTRONS.**
- **WIDE ENERGY RANGE.**

**BGO SUPPRESSION**

# $\gamma$ -rays– Coincident with FF

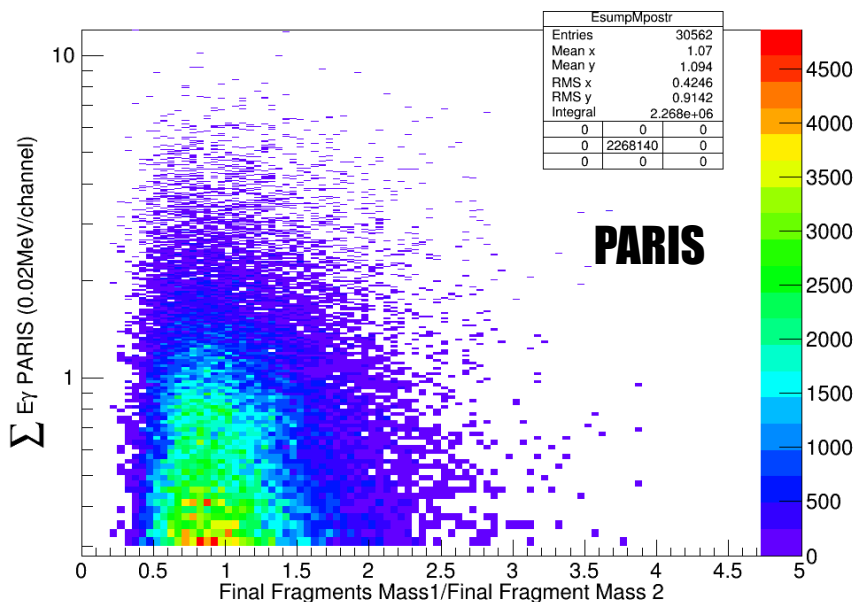
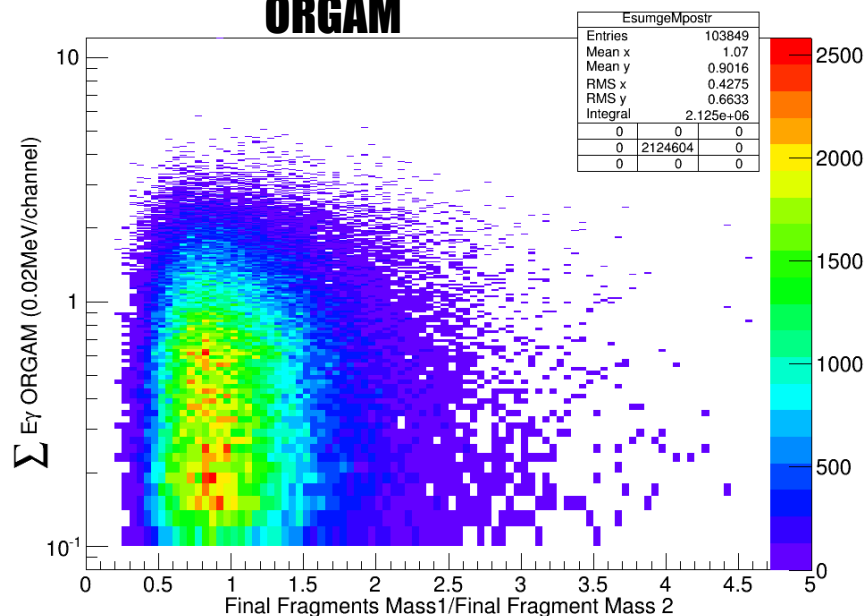
The high energy component of the  $\gamma$ -ray spectrum shows a dependency on the fragment mass split, particularly in the region of masses 120::132





# EFFICIENCY CORRECTED $E_\gamma$

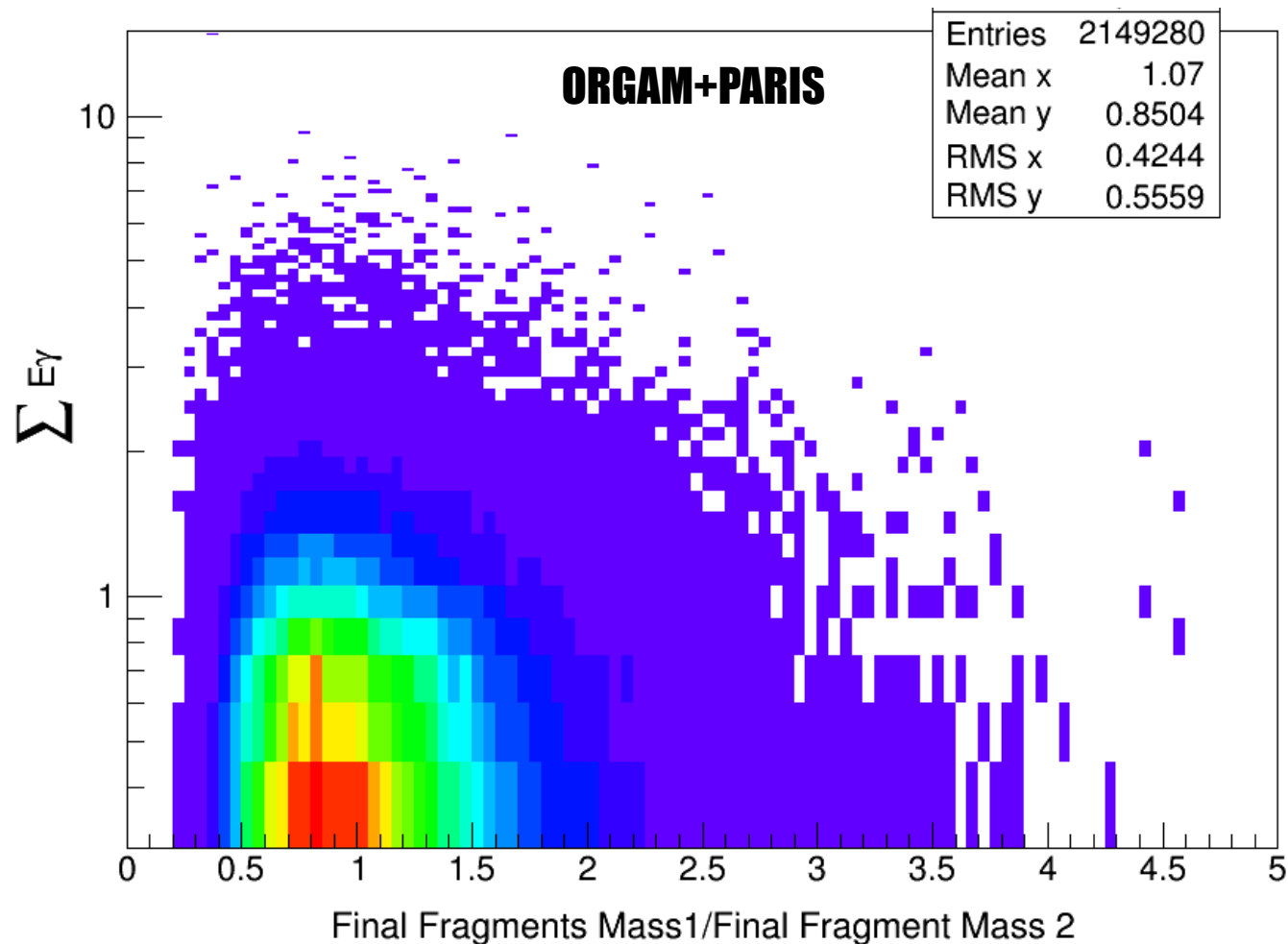
**ORGAM**



The total number of  $\gamma$ s in ORGAM+PARIS after efficiency correction

$$N_\gamma^{ORGAM+PARIS} = 2149280 \rightarrow \langle M_\gamma \rangle = \frac{N_\gamma^{ORGAM+PARIS}}{N_{FF}} = 7.8.$$

**ORGAM+PARIS**





# CAN WE STILL SEE SHELL EFFECTS IN OTHER OBSERVABLES?

## Gamma-Ray Multiplicities and Fission Modes in $^{208}\text{Pb}(^{18}\text{O},f)$

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A. Ya. Rusanov,<sup>4</sup> V. S. Salamatov,<sup>2</sup> and R. P. Schmitt<sup>1</sup>

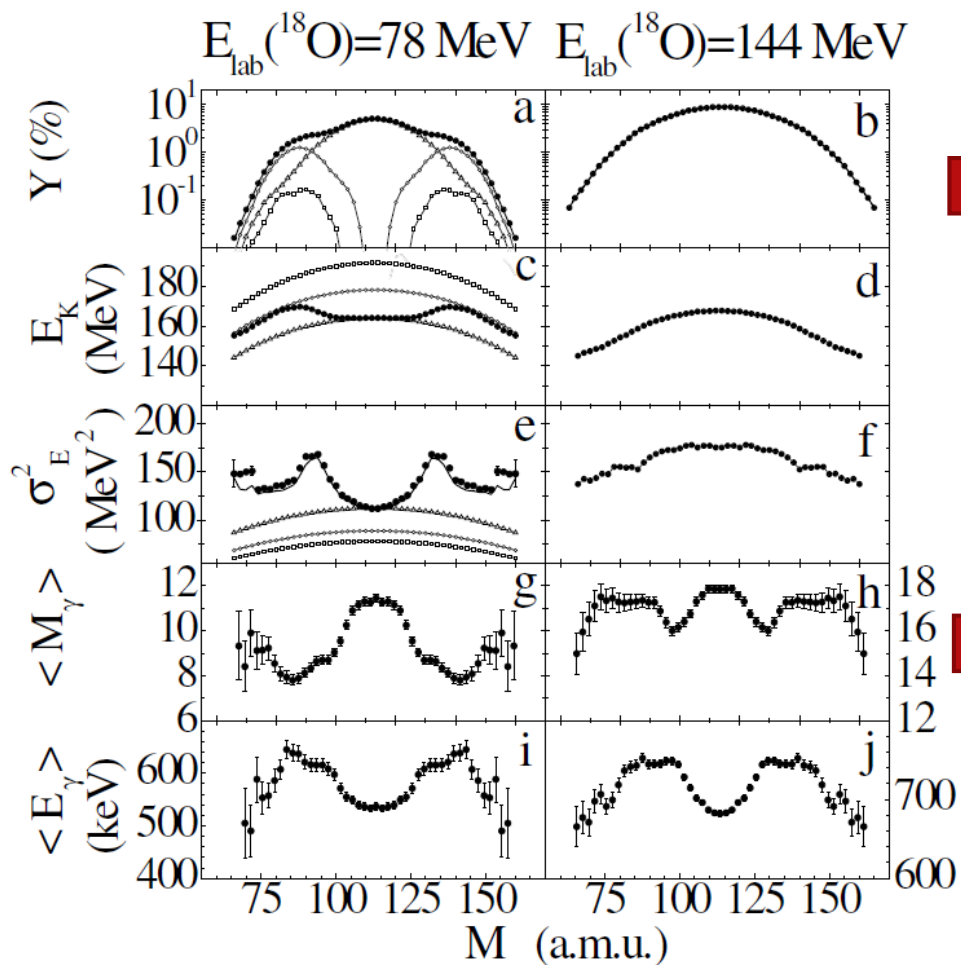
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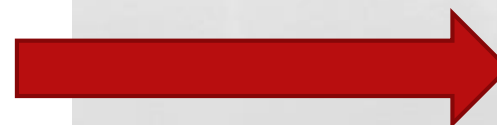
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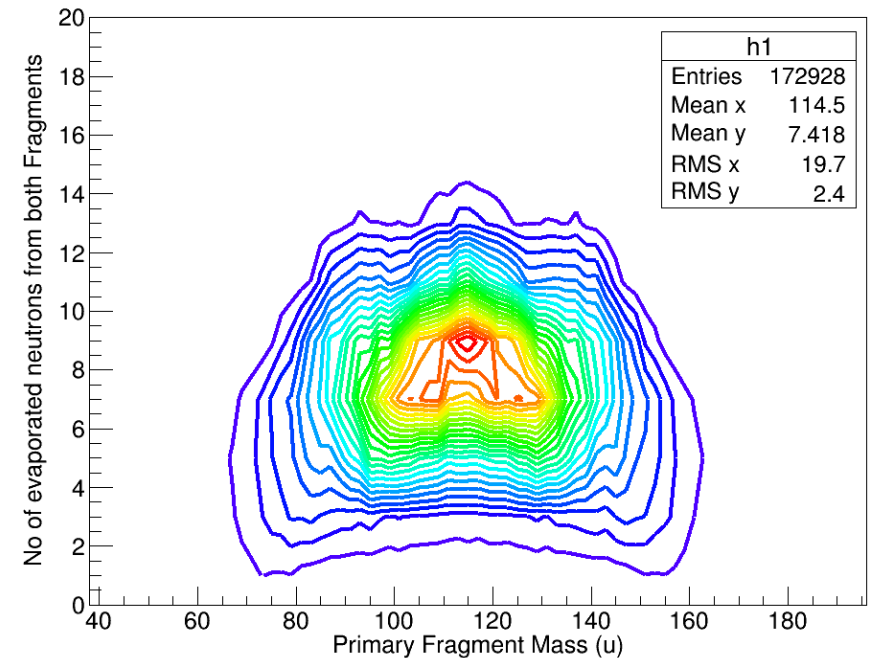
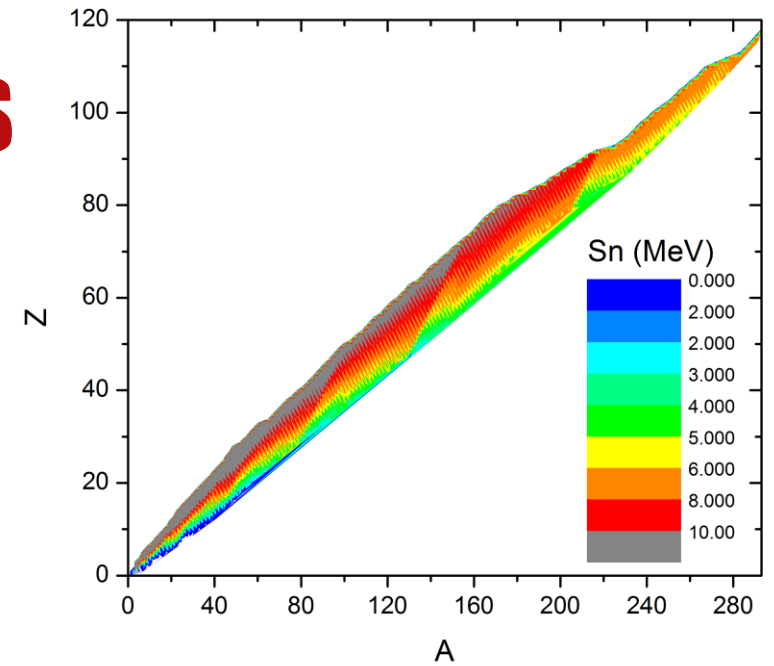
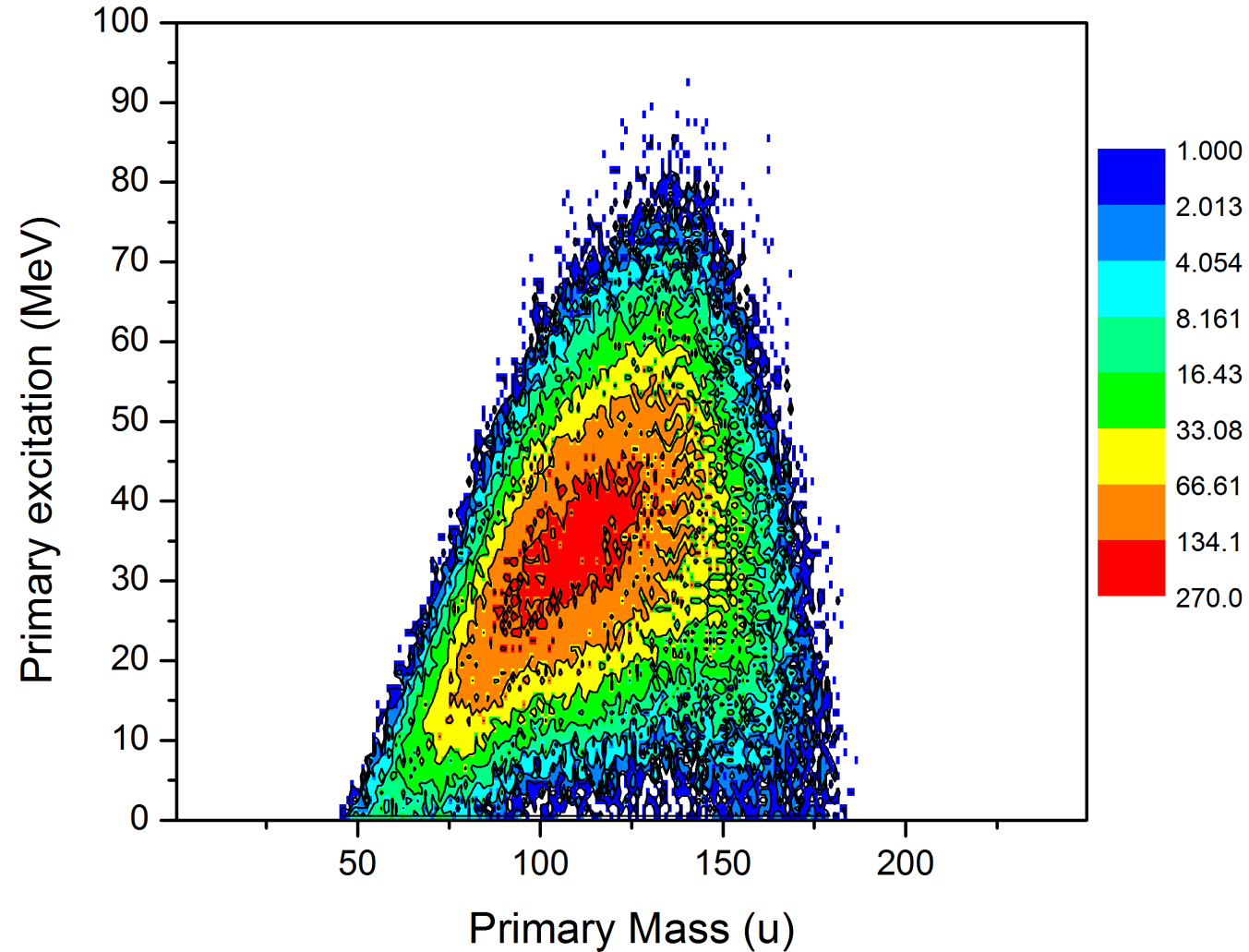


**Shell effects smeared out**



**Shell effects still visible**

# THE EXCITATION ENERGY OF FISSION FRAGMENTS: FROM PRIMARY FRAGMENTS TO FINAL FRAGMENTS



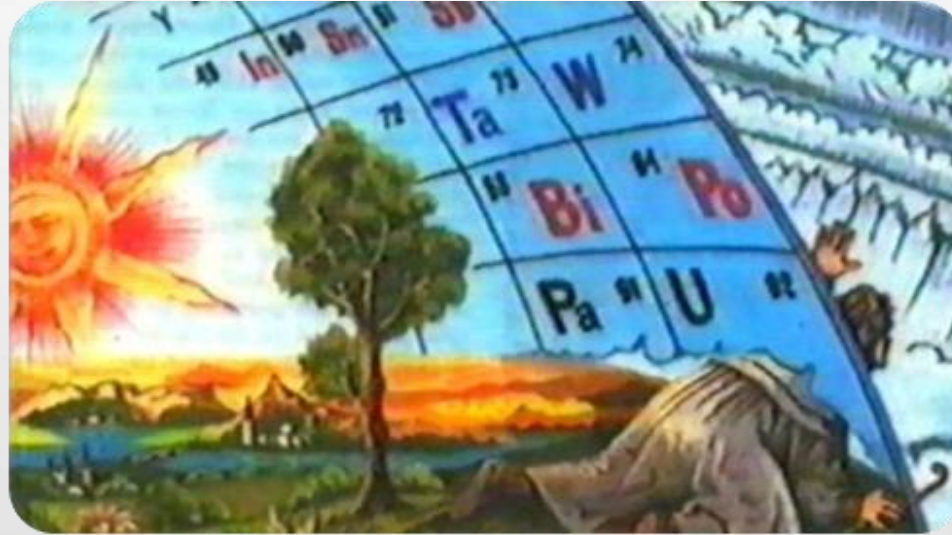
# Conclusions

- **The 3 detection systems CORSET + ORGAM + PARIS were successfully coupled at IPNO;**
- **THE Mass-TKE correlation was obtained within a very good resolution ( 2 amu, 5 MeV);**
- **In an attempt to find signatures of shell effects in fragments, the excitation energy and the neutrons emitted by fragments were extracted;**
- **An attempt to estimate the  $\langle \text{Spin} \rangle(A)$  and  $\langle \text{Spin} \rangle(\text{TKE})$  correlation is under way.**

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Data Analysis still in progress!

# THANK YOU FOR YOUR ATTENTION !



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